

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP03/07761A. CLASSIFICATION OF SUBJECT MATTER  
Int.Cl.<sup>7</sup> H01L29/78, H01L21/336

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
Int.Cl.<sup>7</sup> H01L29/78, H01L21/336, H01L21/316, H01L21/318Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2003  
Kokai Jitsuyo Shinan Koho 1971-2003 Jitsuyo Shinan Toroku Koho 1996-2003Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
ISI Web of Science, IEEE Xplore

## -C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	H.-J. Cho et al., Novel Nitrogen Profile Engineering for Improved TaN/HfO <sub>2</sub> /Si MOSFET Performance, International Electron Devices Meeting., Technical Digest 2001, pages 655 to 658	1-3, 5, 11, 12, 20
Y	pages 655 to 658	4, 8, 9, 11-13
A	pages 655 to 658	16-19
X	Hag-Ju Cho et al., Structural and Electrical Properties of HfO <sub>2</sub> With Top Nitrogen Incorporated Layer, IEEE ELECTRON DEVICE LETTERS, Vol.23, No.5, May 2002, pages 249 to 251	1-3, 5, 11, 12, 20
Y	pages 249 to 251	4, 8, 9, 11-13
A	pages 249 to 251	16-19

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search  
12 September, 2003 (12.09.03)Date of mailing of the international search report  
30 September, 2003 (30.09.03)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP03/07761

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002-60944 A (International Business Machines Corp.), 28 February, 2002 (28.02.02), Par. Nos. [0101] to [0103]; Figs. 5 to 13	1-3, 5-8, 11-13, 15, 20
Y	Par. Nos. [0101] to [0103]; Figs. 5 to 13	4, 8-14
A	Par. Nos. [0101] to [0103]; Figs. 5 to 13 & KR 2001098415 A	16-19
Y	JP 10-242461 A (Sony Corp.), 11 September, 1998 (11.09.98), Full text; Fig. 3 (Family: none)	4
Y	JP 2002-164343 A (Agere Systems Guardian Corp.), 07 June, 2002 (07.06.02), Full text; Fig. 3	9, 11-13
A	Full text; Fig. 3 & GB 2371676 A & KR 2002018617 A & US 2002/0163050 A1	16-19
Y	US 6365467 B1 (Hyundai Electronics Industries Co., Ltd.), 02 April, 2002 (02.04.02), Full text; Fig. 1 & JP 2000-195856 A Full text; Fig. 1 & KR 2000045310 A	10-12, 14
P, X	JP 2002-299607 A (Toshiba Corp.), 11 October, 2002 (11.10.02), Full text; all drawings (Family: none)	1-3, 5-7, 11-13, 15, 20

**Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

As described on the (extra sheet), there must exist a special technical feature so linking a group of inventions of claims as to form a single general inventive concept in order that the group of inventions may satisfy the requirement of unity of invention.

This international application contains three inventions: (1) the invention of claims 1-5, 8, 11-13, 16-19, claims 7, 15, claim 9, and claim 20; (2) the invention of claim 6; and (3) the invention of claims 10, 14.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest** ☐ The additional search fees were accompanied by the applicant's protest.  
☒ No protest accompanied the payment of additional search fees.

Continuation of Box No. II of continuation of first sheet (1)

There must exist a special technical feature so linking a group of inventions of claims as to form a single general inventive concept in order that the group of inventions may satisfy the requirement of unity of invention. The inventions of claims 1-20 are linked only by the technical feature that a "gate insulating film" comprises a "metal silicate film".

However, it is clear, as mentioned in "Background Art" of the description of this application, that this technical feature is a well-known one and cannot be a special technical feature. Therefore there is no special technical feature so linking the group of inventions of claims 1-20 as to form a single general inventive concept.

Consequently, it appears that the inventions of claims 1-20 do not comply with the requirement of unity of invention.

Next, the number of inventions of the claims in the international application so linked as to form a single general inventive concept, namely, the number of inventions will be examined. Considering the specific modes of the inventions of the claims, the claims of the international application define six inventions: the invention of claims 1-5, 8, 11-13, 16-19, the invention of claim 6, the invention of claims 7, 15, the invention of claim 9, the invention of claims 10, 14, and the invention of claim 20. Out of the inventions, the inventions of claims 1-5, 8, 11-13, 16-19 and the claim 6 are linked only by the technical feature that "a gate insulating film" has "a structure in which nitrogen is introduced into a metal silicate". However, this technical feature is also a well-known one and cannot be a special technical feature, as mentioned in "Background Art" of the description. Similarly, the relationship among claims 1-5, 8, 11-13, 16-19 and the claims 10, 14 and the relationship among claim 6 and claims 10, 14 involve no special technical features. The inventions of claims 1-5, 8, 11-13, 16-19, claims 7, 15, claim 9, and claim 20 are linked by the technical feature that "the position where the nitrogen concentration is maximum in the direction of film thickness is in a region away from the silicon substrate", with respect to the technical feature that "a gate insulating film" includes a nitrogen-containing high dielectric constant insulating film having "a structure in which nitrogen is introduced into a metal silicate".

Consequently, there are three inventions in this international application: (1) the invention of claims 1-5, 8, 11-13, 16-19, claims 7-15, claim 9, and claim 20; (2) the invention of claim 6; and (3) the invention of claims 10, 14.